Potential movement of mountain vegetation zones in Scotland under predicted climatic change

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Declaration

I declare that this thesis has been composed by my self. It has not been accepted in any previous application for a degree, the work of which this is a record has been done by myself, any personal data have been processed in accordance with the provisions of the Data Protection Act 1998, and all direct quotations have been distinguished by quotation marks and the sources of information specifically acknowledged.

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Abstract

The global climate has shown an increase of 0.6°C over the last century and a further rise of between 1.5°C and 5.8°C is predicted over the next century. It is expected that ecosystems at high altitudes and latitudes will be particularly sensitive to climatic change. European studies have shown an upward movement of plant species, which has been attributed to climate change. Given the lack of suitable historical surveys to investigate the potential changes in Scottish mountain vegetation due to global climate change over the past century, a different approach was needed.

A two pronged approach was taken: Firstly, it was necessary to collect information on the potential for seed to move from lower vegetation zones to higher levels under predicted climate change. Secondly, it was necessary to determine if an increase in mean temperature, as predicted by the climatic models, would affect the strength of interactions between plants.

In order to investigate the dispersal potential of mountain species, a study was designed to measure seed rain at a number of points along several altitudinal transects in the Grampian Mountains in Scotland, and soil cores were taken to measure the seed bank present. A survey of current vegetation was also carried out at the sites along the altitudinal transects.

Open Top Chambers were used, to simulate the effects of predicted climate change, to test whether this would alter the balance between competition and facilitation in arctic/alpine plant communities. The experiment was set up at 1000 m a.s.l. in the Scottish Highlands, using *Carex bigelowii* and *Alchemilla alpina* as target plants. The target plants were transplanted into replicate environmental treatments. Within each environmental treatment, the target plants were planted with and without neighbours. Measurements were taken of final above ground biomass, as well as environmental variables.

No evidence was found for a significant upward movement of seed. *Calluna* seed has been found in the seedbank at higher altitudes than the surface vegetation. However this is unlikely to lead to *Calluna* colonising the alpine zone under the currently predicted levels of climate change. While the size of the *Calluna* seedbank has not changed significantly from previous studies, the level of *Calluna* seed rain does appear to be declining. The results of the experiment on the balance between competition and facilitation were inconclusive. Unfortunately it was also not possible to determine the relative importance of temperature and wind as an ecological factor in the Scottish alpine zone.

In conclusion mountain vegetation zones in Scotland will not move as whole, but there may be migrations of individual plant species. These migrations could have unexpected consequences and may be in directions different to expectation. Changes in zonation of plant communities are unlikely to be driven by temperature alone, however the currently employed modelling approaches are not sensitive to other factors. There is a need for more field data to understand how climate change will affect the distribution of alpine arctic vegetation, before more reliable models can be developed.

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As I did stand my watch upon
the hill,
I look'd toward Birnam, and anon,
methought,
The wood began to move.

Macbeth, Act 5, Scene 5